Comparison of Linear Analysis of RC Frame Multi F_Level Regular and Irregular Buildings With or Without Shear Wall

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Abstract- *In this thesis a comparison of linear analysis of RC Frame multi f_level (floor level) regular and irregular buildings with or without shear wall in seismic is carried out. In this thesis comparison of seismic analysis linear static and dynamic analysis is done by using loads and load combinations. In this analysis the selection of building is a RC Frame building, which is a multi f_level building. In Indian region country divided four zones (II, III, IV and V) depending on seismic risk. SMRF (special moment resisting frame) building is using in this analysis. Moment resisting frame should resist both gravity and lateral loads and widely used for seismic resisting systems. Taking Rectangular, c-shape and L-shape of building with shear wall and without shear wall and comparing for F_Level drift, joint F_Level displacement, max and avg. F_Level drift, joint displacement and etc. by using 18 loads and load combinations for static analysis and 22 loads and load combinations for dynamic analysis(response spectrum method). For seismic analysis IS 1893(PART 1):2002 and the whole analysis is done with ETABS 2016 software programming.*

Keywords- Regular, Irregular Building, Loads And Load Combinations, ESM (equivalent static method), RSM(response spectrum method), Shear Wall, Linear Analysis, Joint Drift, F_Level Drift, Joint F_Level Displacement Maximum, E-Tabs 2016.

I. INTRODUCTION

A. General

Structural analysis is a very important part of a design of buildings and other built assets such as bridges and tunnels, as structural loads can cause stress, deformation and displacement that may result in structural problems or even failure.

Linear analysis: when the deformations of structures are linear combinations of applied loads, it is called linear. Purpose of the linear analysis is to identify the transformation and inverse transformation between these two set of quantities. This transformation is called stiffness matrix of the structure.
Multi f_level building is generally designed for purpose to serve as a hospital, commercial mall or apartment. A midrise building has number of f_levels ranging from 4 to 12. Regular buildings are in square and rectangular in shape and irregular building are l-shape, e-shape, c-shape, t-shape etc.

seismic analysis: the main parameter of seismic analysis of structures are load carrying capacity, ductility, stiffness and damping and mass, is 1893-2002 is used to carry out seismic analysis of structures. The different analysis procedure is

1. Linear static analysis
2. Nonlinear static analysis.

Shear wall: Shear wall: Shear wall is a structural member used to resist lateral forces i.e. parallel to the plane of the wall, Shear wall resists the loads due to Cantilever Action. In other words, Shear walls are vertical elements of the horizontal force resisting system. Shear walls are especially important in high-rise buildings subject to lateral wind and seismic forces. Generally, shear walls are either plane or flanged in section, while core walls consist of channel sections. They also provide adequate strength and stiffness to control lateral displacements. Shear walls provide large strength and stiffness to buildings in the direction of their orientation, which significantly reduces lateral sway of the building and thereby reduces damage to structure and its contents. Since shear walls carry large horizontal earthquake forces, the overturning effects on them are large. Optimum location of shear walls: the optimum location of shear walls is as

1) Corners of the building
2) Sides walls of the building
3) Core or Centre of the building.

II . LITERATURE REVIEW

Arpana Jain1,Prof. Anubhav Rai2 Prof. Yogesh Kumar Bajpai3(2017) she have done Comparative study of static and dynamic analysis of an Irregular multi-F_Level building with different location of shear wall. Residential building of G+ 11 storied structure for the seismic analysis and it is located in zone III. Different load combinations are considered as per IS 456:2000 and IS 1893(PAR1):2002. In ESM analyses 15 load combinations are considered. In RSM analyses, 20 load combinations are considered. Seismic analysis of multi F_Level is done by using STAD-PRO V8i software. Result showed that the maximum Bending Moment, Shear Force and Displacement is seen in case of RSM at without shear wall structure and minimum in case of ESM at SW at Corner structure. F_Level displacement values observed that maximum reduction in displacement values is obtained when shear walls are provided at corners of the building. Suruchi Mishra(2017) studied the comparison of seismic behaviour of G+10 F_Level buildings having horizontal irregularity with the regular building of similar properties with and without shear wall by using ETAB software was done. For this purpose four multiF_Level building plans are considered that are symmetric plan, L shape, T shape, and + shape. For the comparison, parameters taken are lateral displacement, F_Level drift and Replica period. All the four buildings were analyzed for zone IV. 10 F_Level building without shear wall square, L-shape, and +-shape are good on performance wise. And with shear wall +-shape, L-shape at corners, T-shape at corners. Ashwinkumar B. Karnale (2015) studied presents the results for different configurations of shear walls for 6 F_Level A box system structure that consists of reinforced concrete building. The results compared on the basis of effect observed due to height of structure having shear wall. In this paper The analysis is done for lateral loading. Loads used are equivalent static load as earthquake load. Results obtained from analysis plotted to compare and to have knowledge of behavior of RCC framed structures with shear walls. The use of shear wall is efficient at corner of the structure and less effective when used in low rise building. studied an overview of different research works to be done regarding the study of multi-F_Level RC frame structure with lateral load resisting systems such as shear wall and diagrid system. The present work concerned with the comparative study of seismic analysis of multi-storied building with shear wall and bracing, analysis of multi-F_Level structure of different shear wall locations and heights and proper location of shear wall in the multi-F_Level building etc. result showed that the deflection at the different level in multi-F_Level building with shear wall is comparatively lesser as compare to RC building without shear wall. The F_Level shear is linearly varying to each other but the steel bracing frame system gives the good results than shear wall system. Minesh Rathore1 (2017) studied Considering shear wall effect to prepare a comparative study on an unsymmetrical L shape bare frame with a frame of same geometry and loading with shear walls having different positions on a structure to determine best position of a lateral force resisting shear walls to counteract maximum forces and displacement. the effect of different positions of shear walls in a L shape tall structure under the effect of seismic zone IV& medium style of soil condition. To compare the results Replica shear wall with different configurations Replicas of various useful parameters such as Lateral displacement, F_Level drift, Time period, Base shear, and obtained most effective position of RC shear wall on considered Replicas. Replica and analysis is done in analysis tool ETABS. Assuming material property is linear static. Result showed that Lateral displacement is maximum in absence of shear wall. The shape of shear wall and its position have significant difference in the time period. The value of torsion is maximum for I shape shear wall. the value of torsion is minimum for absence of shear wall. The value of resisting moment is maximum for side shear wall and the value of moment resisting is minimum for absence of shear wall. A. Sampath (2017) studied 3dimentional analytical Replica of 4 and 9 storied buildings had been generated for symmetric and uneven building Replicas and analyzed the use of structural evaluation tool "SAP2000 Nonlinear". The analytical version of the building includes all components that have an impact on the mass, energy, stiffness of the structure. To take a look at the effect of infill at some point of earthquake, seismic evaluation using dynamic evaluation is finished. Result showed that Element forces (frames) decreases from bottom F_Level to top F_Level in all three cases. The period as well as frequency is constant in case of 6. For 11 and 16 stories the values of time period are decreases from step number1 to step number 12. Frequency values for 11 and 16 are increasing from step no. 1 to step no. 12. Base reaction values are more in the EQY loading case in all Replica 6. Base shear of symmetric structure is more as compare to Asymmetric structure. Tensional moment in asymmetric structure is more than symmetric structure.

III. METHODOLOGY

3.1 SEISMIC ANALYSIS:

Earthquake forces are random in nature and unpredictable, the static and dynamic analysis of the structures have become the primary concern of civil engineers. use of analysis in research and practice has increased substantially in recent years due to the proliferation of verified and user-friendly software like (STADD PRO., ETABS and SAP etc.) and the availability of fast computers. The main parameters of the seismic analysis of structures are load carrying capacity, ductility, stiffness, damping and mass. IS 1893-2002 is used to carry out the seismic analysis of multiF_LEVEL building. There are different styles of Seismic analysis methods.

A. Static Method:

This method defines a sequence of forces acting on a building to represent the effect of earthquake ground motion, mostly defined by a seismic design response spectrum. It assumes that the building greets in its fundamental mode. For this to be true, the building must be low-rise building structure and must not twist significantly when the ground shift. The response load of building is read from a design response spectrum, given the natural frequency of the building (either calculated or defined by the building code). The applicability of this method is extended in many building codes of seismic analysis and by applying factors to account for higher buildings with some higher modes, and for low levels of twisting and torsion. To account for effects due to "yielding" of the building structure, many codes apply for modification factors that reduce the design forces (e.g. force reduction factors).Since the Static Equivalent method is accurate and easy for short building especially for single F_Level building.

B. Dynamic Analysis:

Dynamic analysis shall be performed to obtain the design seismic force, and its distribution to different levels along the height of the building and to the various lateral load resisting elements, for the following buildings:

It is performed to obtain the design seismic forces and its distribution to different level along the height of the building and to various lateral load resisting elements for the regular buildings and irregular buildings also as defined in (is-1893 part-1-2000) in clause 7.8.1 In this analysis building height is about 30.3 m and building is in III zone. To follow these rules of regular and irregular building fulfill the above rules as given. Civil engineering structures are mainly designed to resist static loads. Generally the effect of dynamic loads acting on the structure is not considered. This feature of neglecting the dynamic forces sometimes becomes the cause of disaster, particularly in case of earthquake. In case of earthquake forces the demand is for ductility. Ductility is an essential attribute of a structure that must respond to strong ground motions. Larger is the capacity of the structure to deform

plasticity without collapse, more is the resulting ductility and the energy dissipation. This causes

reduction in effective earthquake forces.

a) Time history method:

It is an analysis of the dynamic response of the structure at each increment of time, when its base is subjected to a specific ground motion time hiF_LEVEL. Alternatively, recorded ground motions database from past natural events can be a reliable source for time histories but they are not recorded in any given site to include all seismological characteristics suitable for that site. Recorded ground motions are randomly selected from analogous magnitude, distance and soil condition category (bin); three main parameters in time history F_LEVEL generation

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b) Response spectrum method:

earthquake response spectrum is the most popular tool in the seismic analysis of structures. There is computational edge in using the response spectrum method (RSM) of seismic analysis for forecast of displacements and member forces in structural systems. The method can requires the calculation of only the maximum values of the displacements and member forces in each mode of vibration using smooth design spectra that are the average of several seismic motions.The response spectral values depends upon the following parameters as: Energy release mechanism, Epicentral distance, Focal depth, Soil condition, Richter magnitude, Damping in the system,Time period of the system.

3.2 Problem Description

In this thesis work a comparative study of linear analysis of RC Frame multi storey regular and irregular buildings with or without shear wall in seismic analysis is carried out. In this thesis comparison of seismic analysis linear static and dynamic analysis is done by using loads and load combinations. A comparison of results in terms of F_Level drift, F_Level displacement, shear force etc. has been made. This analysis is done using simplified code method as per IS 1893 (PART 1):2002 for seismic analysis. A 10 F_Level (G+9) reinforced concrete buildings of different configuration in medium soil has a plan of rectangular shape, c-shape and L-shape, which is given as below and its height is 30.3m. The different configurations considered are shear walls at corners, side of the building and core arranged. The grade of concrete is M-25 and that of steel is Fe 415.

The column size is of 0.70m x 0.50m and the beam size is 0.30m x 0.50m at inner side and 0.30m x 0.40m at outer side.Unit weight of R.C.C: 25 KN/m3 as per table 1 (page 6), IS 875(PART 1):1987.

Unit weight of Masonry: 20 KN/m3 as per table 1 (page 8), IS 875(PART 1):1987.

Modulus of elasticity for concrete, Ec: 5000√fck as per IS 456:2000.
Where fck= characteristic compressive strength of concrete.
Poison's ratio for concrete: 0.17
The thickness of slab: 150mm.
The height of base floor is 3.3m and each floor ht. is 3m.
All the cases are assumed to have fixed support.
The analysis is done in ETABS 2016 software.

3.3 Structure Description

S.no.	Specifications	Details
1	Number of stories	G+9 (10)
2	Ground F_LEVEL ht.	3.3 m
3	Floor to floor ht.	3 m
4	Floor thickness	150 mm
5	Shear Wall thickness	230 mm
6	Style of structure	SMRF
7	Layout	As shown in fig.
8	Design philosophy	Limit state method conforming IS 456:2000
9	Column	700 x 500 mm^2
10	Inner Beam	300 x 500mm^2
11	Outer beam	300x400 mm^2
12	Analysis	Software programming calculated (E-TABS 2016)
13	Prefixing M to the desired strength	M 25
14	Grade of steel	Fe 415
15	Rebar	HYSD 415
16	Earthquake Zone	III
17	Damping ratio	0.05
18	Importance factor	1
19	Style of soil	Medium soil
20	Response reduction factor	5
21	Zone factor	0.16
22	CODE	IS 1893 (PART 1):2002
23	Dead load	2 KN/m^2
24	Live load	3 KN/m^2

Table 1: geometric descriptions

3.4 Remove all load combinations of RS (response load case number as 6,19,20,21,22) which is given below the chart and use remaining 18 load combinations for ESM (Equivalent static method) analysis.

S.no.	Load combos
1	DL (DEAD LOAD)
2	LL (LIVE LOAD)
3	1.5 DL
4	EQ X
5	EQ Y
6	RS (RESPONSE LOAD)
7	1.5(DL+LL)
8	0.9 DL+1.5 EQ X
9	0.9 DL+ 1.5 EQ Y
10	0.9 DL-1.5 EQ X
11	0.9 DL- 1.5 EQ Y
12	1.2 (DL+LL + EQ X)
13	1.2 (DL+LL- EQ X)
14	1.2 (DL+LL+ EQ Y)
15	1.2 (DL+LL- EQ Y)
16	1.5 (DL+ EQ X)
17	1.5 (DL- EQ X)
18	1.5 (DL+ EQ Y)
19	1.5 (DL- EQ Y)
20	1.5 (DL+RS)
21	1.5 (DL-RS)
22	1.2 (DL+LL+RS)
23	1.2 (DL+LL-RS)

Table 2: load and load combinations

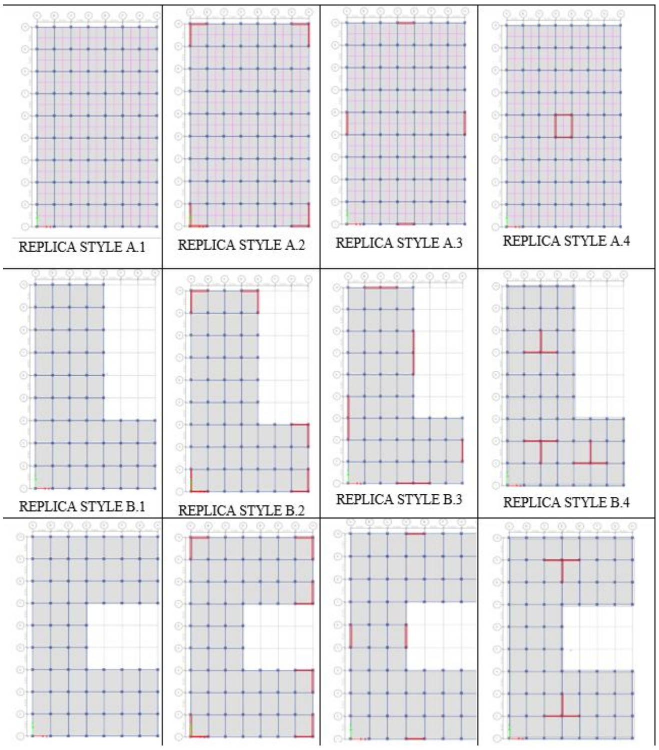
3.5 In all Replicas are made and analyzed. Following cases of building frames are considered-

CASES	STRUCTURE	SHEAR WALL	ANALYSIS	METHOD
Case 1	Rectangular Rc Frame	Without Shear Wall	Seismic	ESM
Case 2	Rectangular Rc Frame	Shear Wall At Corner	Seismic	ESM
Case 3	Rectangular Rc Frame	Shear Wall At Side	Seismic	ESM
Case 4	Rectangular Rc Frame	Shear Wall At Core	Seismic	ESM
Case 5	Rectangular Rc Frame	Without Shear Wall	Seismic	RSM
Case 6	Rectangular Rc Frame	Shear Wall At	Seismic	RSM

		Corner		
Case 7	Rectangular Rc Frame	Shear Wall At Side	Seismic	RSM
Case 8	Rectangular Rc Frame	Shear Wall At Core	Seismic	RSM
Case 9	C-Shape Rc Frame	Withou t Shear Wall	Seismic	ESM
Case 10	C-Shape Rc Frame	Shear Wall At Corner	Seismic	ESM
Case11	C-Shape Rc Frame	Shear Wall At Side	Seismic	ESM
Case 12	C-Shape Rc Frame	Shear Wall At Core	Seismic	ESM
Case 13	C-Shape Rc Frame	Withou t Shear Wall	Seismic	RSM
Case 14	C-Shape Rc Frame	Shear Wall At Corner	Seismic	RSM
Case 15	C-Shape Rc Frame	Shear Wall At Side	Seismic	RSM
Case 16	C-Shape Rc Frame	Shear Wall At Core	Seismic	RSM
Case 17	L-Shape Rc Frame	Withou t Shear Wall	Seismic	ESM
Case 18	L-Shape Rc Frame	Shear Wall At Corner	Seismic	ESM
Case 19	L-Shape Rc Frame	Shear Wall At Side	Seismic	ESM
Case 20	L-Shape Rc Frame	Shear Wall At Core	Seismic	ESM
Case 21	L-Shape Rc Frame	Withou t Shear Wall	Seismic	RSM
Case 22	L-Shape Rc Frame	Shear Wall At Corner	Seismic	RSM
Case 23	L-Shape Rc Frame	Shear Wall At Side	Seismic	RSM
Case 24	L-Shape Rc Frame	Shear Wall At Core	Seismic	RSM

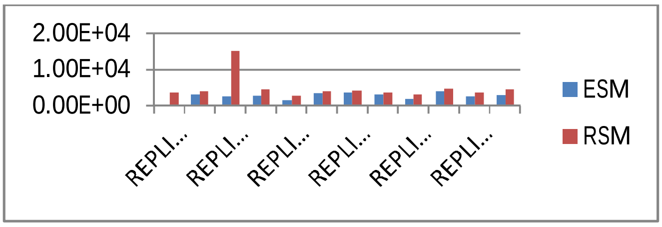
Table 3: all replica cases

3.6 Structural Replicas As: structural replicas for different cases are as in figures



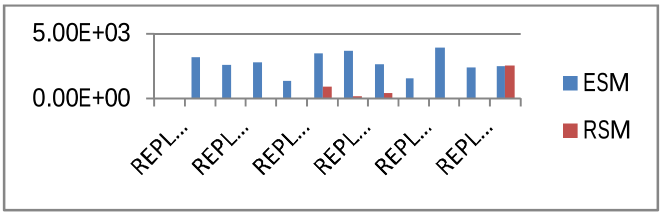
IV. RESULT AND DISCUSSIONS

a. Shear force in x-direction: comparison of maximum shear force in x-direction for all replicas.



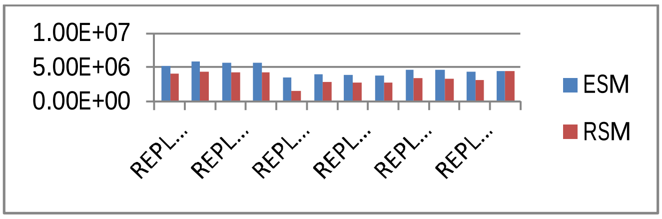
F_LEVEL shear force in X direction- It is observed that maximum F_LEVEL shear force is seen in RSM and minimum is ESM. In RSM the maximum F_LEVEL shear force is seen for the Replica A.3 and minimum is Replica B.1. In ESM the maximum F_LEVEL shear force is Replica C.2 and minimum for Replica B.1. It is also seen that shear wall at side for rectangular Replica gives the maximum value and without shear wall L-shape gives the minimum value in RSM. Similarly as Replica C.2 which is in C-shape multi F_LEVEL building shear wall at corner gives the higher value and minimum for L-shape Replica without shear wall in ESM.

b. Shear force in y- direction: comparison of maximum shear force in y-direction for all replicas.



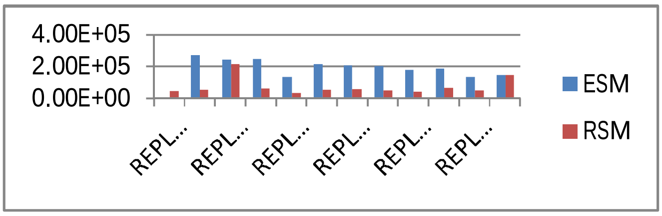
F_LEVEL shear force in Y-direction- It is observed that maximum F_LEVEL shear force is seen in ESM and minimum is RSM. In RSM the maximum F_LEVEL shear force is seen for the Replica C.4 and minimum is Replica A.1. In ESM the maximum joint displacement is Replica C.2 and minimum for Replica A.1. It is also seen that shear wall at core for C-shape Replica gives the maximum value and without shear wall rectangular structure gives the minimum value in RSM. Similarly as Replica C.2 which is C-shape multi F_LEVEL building shear wall at corner gives the higher value and minimum for rectangular REPLICA without shear wall in ESM.

c. Bending moment in x- direction: comparison of maximum bending moment in x-direction for all replicas.



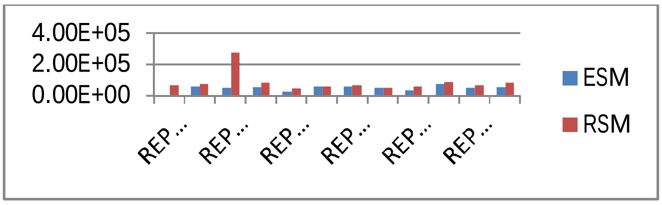
Bending moment in X direction- It is observed that maximum bending moment is seen in ESM and minimum is RSM. In RSM the maximum bending moment is seen for the Replica C.4 and minimum is Replica B.1. In ESM the maximum bending moment is Replica A.2 and minimum for Replica B.1. It is also seen that shear wall at core for C-shape Replica gives the maximum value and without shear wall L-Shape Replica gives the minimum value in RSM. Similarly as Replica A.2 which is in rectangular multi F_Level building shear wall at corner gives the higher value and minimum for L-shape Replica without shear wall in ESM.

d. Bending moment in y- direction: comparison of maximum bending moment in y-direction for all replicas.



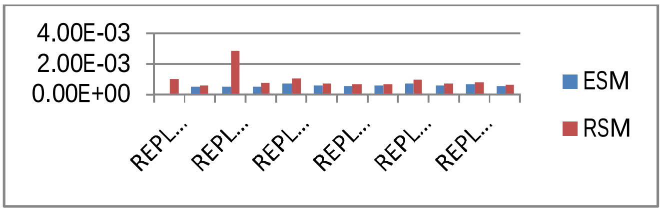
Bending moment in Y-direction- It is observed that maximum bending moment is seen in ESM and minimum is RSM. In RSM the maximum bending moment is seen for the Replica A.3 and minimum is Replica B.1. In ESM the maximum bending moment is Replica A.2 and minimum for Replica A.1. It is also seen that shear wall at side for rectangular Replica gives the maximum value and without shear wall L-shape structure gives the minimum value in RSM. Similarly as Replica B.1 which is rectangular multi F_Level building shear wall at corner gives the higher value and minimum for rectangular Replica without shear wall in ESM.

e. Torsion moment in Z- direction: comparison of maximum torsion moment in Z-direction for all replicas.



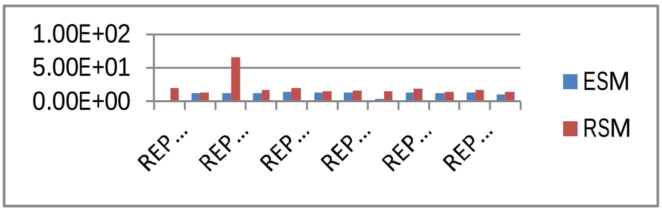
Torsional moment in Z-direction- It is observed that maximum torsional moment is seen in RSM and minimum is ESM. In RSM the maximum torsional moment is seen for the Replica A.3 and minimum is Replica B.1. In ESM the maximum torsional moment is Replica C.2 and minimum for Replica A.1. It is also seen that shear wall at side for rectangular Replica gives the maximum value and without shear wall L-shape gives the minimum value in RSM. Similarly as Replica C.2 which is in C-shape multiF_LEVEL building shear wall at corner gives the higher value and minimum for rectangular Replica without shear wall in ESM.

f. F_level drift (story drift) in x-direction: comparison of maximum F_level drift in x-dirn for all reeplica



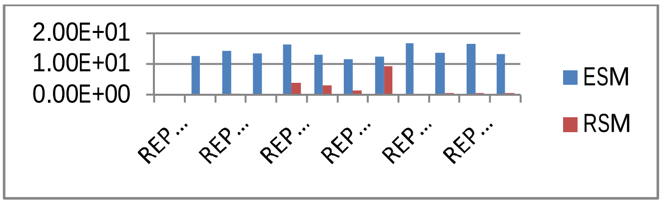
F_LEVEL drift in X direction- It is observed that maximum F_Level drift is seen in RSM and minimum is ESM. In RSM the maximum F_Level drift is seen for The Replica A.3 and minimum is Replica A.2. In ESM the maximum F_Level drift is Replica C.1 and minimum for Replica A.1. It is also seen that shear wall at side for rectangular Replica gives the maximum value and at corner shear wall rectangular Replica gives the minimum value in RSM. Similarly as Replica C.1 which is C-shape multiF_Level building without shear wall gives the higher value and minimum for rectangular Replica without shear wall in ESM.

g.Joint displacement in x- direction: comparison of maximum joint displacement in x-direction for all replicas.



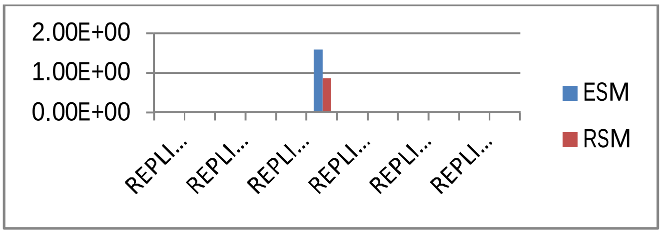
Joint displacement in X direction-
It is observed that maximum joint displacement is seen in RSM and minimum is ESM.
In RSM the maximum joint displacement is seen for the Replica A.3 and minimum is Replica A.2. In ESM the maximum joint displacement is Replica B.1 and minimum for Replica A.1. It is also seen that shear wall at side for rectangular Replica gives the maximum value and at corner shear wall gives the minimum value in RSM. Similarly as Replica B.1 which is in L shape multi F_LEVEL building without shear wall gives the higher value and minimum for rectangular Replica without shear wall in ESM.

h. Joint displacement in y- direction: comparison of maximum joint displacement in y-direction for all replicas.



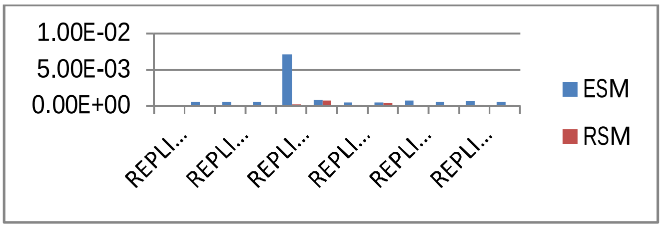
Joint displacement in Y-direction- It is observed that maximum joint displacement is seen in ESM and minimum is RSM, because response load applied only in X-direction. In RSM the maximum joint displacement is seen for the Replica B.4 and minimum is Replica A.1. In ESM the maximum joint displacement is Replica C.1 and minimum for Replica A.1. It is also seen that shear wall at core for L-shape Replica gives the maximum value and without shear wall for rectangular structure gives the minimum value in RSM. Similarly as Replica C.1 which is C-shape multiF_Level building without shear wall gives the higher value and minimum for rectangular Replica without shear wall in ESM.

i. Joint drift in x- direction: comparison of maximum joint drift in x-direction for all replicas.



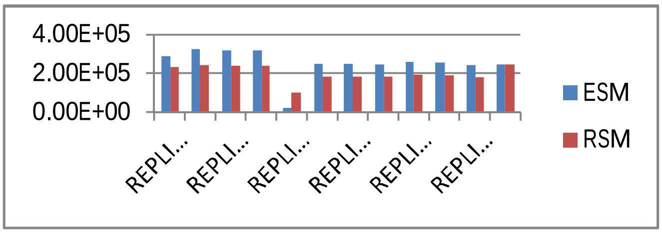
Joint drift in X direction- It is observed that maximum joint drift is seen in ESM and minimum in RSM. In RSM the maximum joint drift is seen for the Replica B.2 and minimum is Replica A.2. In ESM the maximum joint drift is Replica B.2 and minimum for Replica A.1. It is also seen that shear wall at corner for L-shape Replica gives the maximum value and at shear wall at corner for rectangular structure gives the minimum value in RSM. Similarly as Replica B.2 which is in L shape multiF_LEVEL building shear wall at corner gives the higher value and minimum for rectangular Replica without shear wall in ESM.

j. Joint drift in y- direction: comparison of maximum joint drift in y-direction for all replicas.



Joint drift in Y-direction- It is observed that maximum joint drift is seen in ESM and minimum is RSM. In RSM the maximum joint drift is seen for the Replica B.2 and minimum is Replica A.3. In ESM the maximum joint drift is Replica B.1 and minimum for Replica A.1. It is also seen that shear wall at corner L-shape Replica gives the maximum value and at side shear wall rectangular structure gives the minimum value in RSM. Similarly as Replica B.1 which is in L shape multiF_LEVEL building without shear wall gives the higher value and minimum for rectangular Replica without shear wall in ESM.

k. F_level force in Z- direction: comparison of maximum F_level force in Z-direction for all replicas.



F_LEVEL force in Z-direction- It is observed that maximum F_LEVEL force is seen in ESM and minimum is RSM. In RSM the maximum F_LEVEL force is seen for the Replica C.4 and minimum is Replica B.1. In ESM the maximum F_LEVEL force is Replica A.2 and minimum for Replica B.1. It is also seen that shear wall at core for C-shape Replica gives the maximum value and without shear wall L-shape structure gives the minimum value in RSM. Similarly as Replica A.2 which is rectangular multiF_LEVEL building shear wall at corner gives the higher value and minimum for L-shape Replica without shear wall in ESM.

V. CONCLUSION

Here in this work ESM (Equivalent static method) and RSM (Response spectrum method) is analyzed with all the Replica cases of structure with and without shear wall. The conclusion of this work is as follows.
Joint Displacement:

• Joint displacement in x-direction observed maximum value is seen in RSM and minimum in ESM. Similarly Joint displacement in y-direction observed maximum value is seen in ESM and minimum in RSM.

- The minimum value in x-direction chronological order of Replica style for ESM is Replica style B.1, style C.3, style B.2, style B.3, style C.1, style A.3, style C.2, style A.4, style A.2, style C.4, style B.4, style A.1 and for RSM is Replica style A.3, style B.1, style A.1, style C.1, style C.3, style A.4, style B.3, style B.2, style B.4, style C.2, style C.4, style A.2.

- The minimum value in y-direction chronological order of REPLICA style for ESM is REPLICA style C.1, style C.3, style B.1, style A.3, style C.2, style A.4, style C.4, style B.2, style A.2, style B.4, style B.3, style A.1and for RSM is REPLICA style B.4, style B.1, style B.2, style B.3, style C.4, style C.3, style C.2, style A.3, style C.1, style A.4, style A.1, style A.2.
- Joint Drift:

- Joint drift in x-direction observed maximum value is seen in ESM and minimum in RSM. Similarly Joint drift in y-direction observed maximum value is seen in ESM and minimum in RSM.
- The minimum value in x-direction chronological order of REPLICA style for ESM is REPLICA style 22, style B.1, style C.1, style C.3, style C.2, style B.4, style A.3, style B.3, style A.4, style A.2, style C.4, style A.1 and for RSM is Replica style 22, style A.3, style B.1, style A.1, style C.1, style C.3, style A.4, style C.2, style B.3, style B.4, style C.4, style A.2.

- The minimum value in y-direction chronological order of REPLICA style for ESM is REPLICA style 21, style B.2, style C.1, style C.3, style A.3, style C.2, style A.4, style C.4, style A.2, style B.4, style B.3, style A.1and for RSM is REPLICA style 24, style B.2, style B.1, style B.3, style C.3, style A.3, style C.4, style A.2, style C.2, style A.4, style C.1, style A.1.

F_LEVEL Shear Force:

- F_LEVEL shear force in x-direction observed maximum value is seen in RSM and minimum in ESM. Similarly Joint drift in y-direction observed maximum value is seen in ESM and minimum in RSM.

- The minimum value in x-direction chronological order of REPLICA style for ESM is REPLICA style 32, style B.3, style B.2, style B.4, style A.2, style C.4, style A.4, style A.3, style C.3, style C.1, style B.1, style A.1 and for RSM is REPLICA style 13, style C.2, style C.4, style A.4, style B.3, style A.2, style B.2, style B.4, style C.3, style A.1, style C.1, style B.1.

- The minimum value in y-direction chronological order of REPLICA style for ESM is REPLICA style 32, style B.3, style B.2, style A.2, style A.4, style B.4, style A.3, style C.4, style C.3, style C.1, style B.1, style A.1and for RSM is REPLICA style 34, style B.2, style B.4, style B.3, style B.1, style C.2, style A.3, style A.2, style A.4, style C.3, style C.1, style A.1.

F_LEVEL Bending Moment:

- Bending moment in x-direction observed maximum value is seen in ESM and minimum in RSM. Similarly Joint drift in y-direction observed maximum value is seen in ESM and minimum in RSM.

- The minimum value in x-direction chronological order of REPLICA style for ESM is REPLICA style 12, style A.4, style A.3, style A.1, style C.1, style C.2, style C.4, style C.3, style B.2, style B.3, style B.4, style B.1 and for RSM is REPLICA style 34, style A.2, style A.3, style A.4, style A.1, style C.1, style C.2, style C.3, style B.2, style B.3, style B.4, style B.1.

- The minimum value in y-direction chronological order of REPLICA style for ESM is REPLICA style 12, style A.4, style A.3, style B.2, style B.3, style B.4, style C.2, style C.1, style C.4, style B.1, style C.3, style A.1and for RSM is REPLICA style 13, style C.4, style C.2, style A.4, style B.3, style A.2, style B.2, style B.4, style C.3, style A.1, style C.1, style B.1.

- ESM showed greater bending moment than RSM. The difference in ESM and RSM in moment for without shear wall structure is around 14% and for corner shear wall is 9% and side shear wall 7.3% and at core difference is 13.60%

- **F_LEVEL Force:**

- F_LEVEL force observed maximum value is seen in ESM and minimum in RSM.

- The minimum value in chronological order of REPLICA style for ESM is REPLICA style 12, style A.3, style A.4, style A.1, style C.1, style C.2, style B.2, style B.3, style B.4, style C.4, style C.3, style B.1 and for RSM is REPLICA style 34, style A.2, style A.3, style A.4, style A.1, style C.1, style C.2, style B.2, style B.3, style B.4, style C.3, style B.1.

Torsional Moment:

- Torsional moment observed maximum value is seen in RSM and minimum in ESM.

- The minimum value in chronological order of REPLICA style for ESM is REPLICA style 32, style B.3, style A.2, style B.2, style C.4, style A.4, style A.3, style B.4, style C.3, style C.1, style B.1, style A.1 and for RSM is REPLICA style 13, style C.2, style C.4, style A.4, style A.2, style C.3, style A.1, style B.3, style B.2, style C.1, style B.4, style B.1.

F_LEVEL drift:

- F_LEVEL drift observed maximum value is seen in RSM and minimum in ESM.

- The minimum value in chronological order of REPLICA style for ESM is REPLICA style 31, style B.1, style C.3, style B.2, style C.2, style B.4, style B.3, style C.4, style A.4, style A.3, style A.2, style A.1 and for RSM is REPLICA style 13, style B.1, style A.1, style C.1, style C.3, style A.4, style B.2, style C.2, style B.3, style B.4, style C.4, style A.2.

From the above comparison of joint F_LEVEL displacement values, it can be observed that the maximum reduction in displacement values is obtained when shear wall provided at corner for rectangular REPLICA. So, from the above graph and table it is observed that RSM is better than ESM because it reduces various parameters like bending moment, F_LEVEL force, joint drift. ESM is better than RSM for torsional moment, F_LEVEL drift, joint displacement.

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